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TECHNICAL FIELD PRIOR ART EFFECT OF THE
INVENTION TECHNICAL PROBLEM MEANS
DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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Notes:

1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

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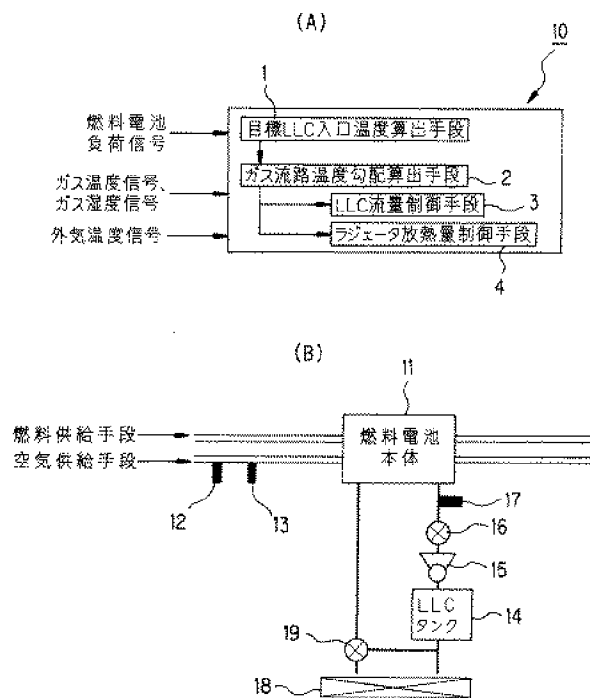
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CLAIM + DETAILED DESCRIPTION

[Claim(s)]

[Claim 1]

It is a polymer electrolyte fuel cell which laminates a single cell which has a film and an electrode zygote which arranges an electrode layer, and a separator arranged at both the external surfaces of its film and electrode zygote to both sides of an electrolyte layer of a solid polymer film, is formed in them, and generates electricity by carrying out conduction of the reactant gas to the separator, Among separators of said single cell, at least, [one of separators] It is a separator of a porous type which forms in a field by the side of said film and electrode zygote the 1st gas stream way in which conduction is possible for said reactant gas, and forms in a field by the side of said film and electrode zygote, and a field by the side of opposite the 2nd gas stream way in which conduction is possible for said

Drawing selection Representative draw

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reactant gas,

It has a communicating means which opens said 1st gas stream way and the 2nd gas stream way for free passage.

A polymer electrolyte fuel cell characterized by things.

[Claim 2]

After making the upper stream and said 2nd gas stream way into the lower stream for said 1st gas stream way and making said 1st gas stream way carry out conduction of said reactant gas, said 2nd gas stream way is made to carry out conduction.

The polymer electrolyte fuel cell according to claim 1 characterized by things.

[Claim 3]

Said 1st gas stream way and said 2nd gas stream way are made to adjoin by back-and-front both sides of said separator.

A gas inlet part which supplies said reactant gas to said 1st gas stream way, and a gas outlet section which discharges said reactant gas from said 2nd gas stream way were provided so that it might approach by the back and front of said separator.

The polymer electrolyte fuel cell according to claim 1 or 2 characterized by things.

[Claim 4]

Said 1st gas stream way has an entrance passage part which had a gas inlet part which supplies said reactant gas to one end, and the other end has closed, and a free passage connecting channel part which one end has closed and connects said communicating means to the other end.

A polymer electrolyte fuel cell given in any 1 paragraph from Claim 1 characterized by things to Claim 3.

[Claim 5]

It was made for pressure of gas which flows through said 1st gas stream way to become high pressure rather than pressure of gas which flows through said 2nd gas stream way.

A polymer electrolyte fuel cell given in any 1 paragraph from Claim 1 characterized by things to Claim 4.

[Claim 6]

It was made to produce pressure difference of pressure of gas which flows through said 1st gas stream way, and pressure of gas which flows through said 2nd gas stream way by pressure loss of said communicating means.

The polymer electrolyte fuel cell according to claim 5 characterized by things.

[Claim 7]

It has a pressure loss control means which controls pressure loss of said communicating means.

The polymer electrolyte fuel cell according to claim 6 characterized by things.

[Claim 8]

Said pressure loss control means controls pressure loss according to load of a fuel cell.

The polymer electrolyte fuel cell according to claim 7 characterized by things.

[Claim 9]

Said communicating means is a penetration hole which penetrates said separator.

A polymer electrolyte fuel cell given in any 1 paragraph from Claim 1 characterized by things to Claim 8.

[Claim 10]

The section area of said penetration hole is smaller than section area of said 1st gas stream way.

The polymer electrolyte fuel cell according to claim 9 characterized by things.

[Claim 11]

Said communicating means is an external manifold which opens said 1st gas stream way and the 2nd gas stream way for free passage in the exterior of said separator.

A polymer electrolyte fuel cell given in any 1 paragraph from Claim 1 characterized by things to Claim 8.

[Claim 12]

It was made for mean temperature of said 1st gas stream way to become high temperature rather than mean temperature of said 2nd gas stream way.

A polymer electrolyte fuel cell given in any 1 paragraph from Claim 1 characterized by things to Claim 11.

[Claim 13]

It has a separator cooling method which cools said one separator from said 2nd gas stream way side.

The polymer electrolyte fuel cell according to claim 12 characterized by things.

[Claim 14]

said 1st gas stream way meets a channel before a part of channel at least from said gas inlet part -- temperature --
***** -- it was made like

A polymer electrolyte fuel cell given in any 1 paragraph from Claim 1 characterized by things to Claim 13.

[Claim 15]

Temperature of reactant gas discharged from a gas outlet section of said 2nd gas stream way was decided based on either one of operating pressure power or a rate of gas utilization at least.

The polymer electrolyte fuel cell according to claim 14 characterized by things.

[Claim 16]

A temperature gradient of reactant gas supplied from a gas inlet part of said 1st gas stream way was decided based on either one of temperature of a gas inlet part, or humidity of a gas inlet part at least.

The polymer electrolyte fuel cell according to claim 15 characterized by things.

[Claim 17]

A temperature gradient of reactant gas supplied from a gas inlet part of said 1st gas stream way was amended according to a rate of gas utilization of a fuel cell.

The polymer electrolyte fuel cell according to claim 16 characterized by things.

[Claim 18]

It is a polymer electrolyte fuel cell which laminates a single cell which has a film and an electrode zygote which arranges an electrode layer, and a separator arranged at both the external surfaces of its film and electrode zygote to both sides of an electrolyte layer of a solid polymer film, is formed in them, and generates electricity by carrying out conduction of said reactant gas to the separator,

Among separators of said single cell, at least, [one of separators] A gas inlet part which supplies said reactant gas to a field by the side of said film and electrode zygote, and an outward trip gas stream way open for free passage, It is a solid type separator which forms a return trip gas stream way which is parallel to the outward trip gas stream way, is connected with the outward trip gas stream way via a turned part, and discharges said reactant gas from the opposite side of the turned part,

A temperature gradient was given so that temperature might rise from said gas inlet part at least toward said turned part from the gas inlet part to [a part of] a turned part.

A polymer electrolyte fuel cell characterized by things.

[Claim 19]

Temperature of gas of a gas outlet section of said 2nd gas stream way was decided based on either one of operating pressure power or a rate of gas utilization at least.

The polymer electrolyte fuel cell according to claim 18 characterized by things.

[Claim 20]

A temperature gradient of reactant gas supplied from a gas inlet part of said 1st gas stream way was decided based on either one of gas inlet temperature or gas inlet humidity at least.

The polymer electrolyte fuel cell according to claim 19 characterized by things.

[Claim 21]

A temperature gradient of reactant gas supplied from a gas inlet part of said 1st gas stream way was amended according to a rate of gas utilization of a fuel cell.

The polymer electrolyte fuel cell according to claim 20 characterized by things.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention uses the film and electrode zygote which arranges an electrode layer for both sides of the electrolyte layer of a solid polymer film, and relates to the polymer electrolyte fuel cell which changes into electric energy the chemical energy which fuel has.

[0002]

[Description of the Prior Art]

A fuel cell system is a system which changes into electric energy directly the chemical energy which fuel has.

While supplying the fuel gas which contains hydrogen in one electrode (anode; anode electrode) among a pair of electrodes provided on both sides of the electrolyte membrane, The oxygen agent gas which contains oxygen in the electrode (negative pole; cathode electrode) of another side is supplied, and electric energy is taken out from an electrode using the following Electrochemistry Sub-Division reaction produced on the surface by the side of these pairs of an of electrolyte membranes of an electrode.

[0003]

Anodic reaction: $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$ ---- (1)

Negative-pole reaction: $2\text{H}^+ + 2\text{e}^- + (1/2) \text{O}_2 \rightarrow \text{H}_2\text{O}$ ---- (2)

[as a method of supplying fuel gas to an anode (anode electrode)] The method of supplying directly from hydrogen storing devices (for example, a high-pressure gas tank, a liquefaction hydrogen tank, a hydrogen storing metal alloy tank, etc.), the method of supplying the hydrogen content gas which carried out property modification of the fuel (for example, natural gas, methanol, gasoline, etc.) containing hydrogen, and generated it, etc. are known. Generally as fuel gas supplied to the negative pole (cathode electrode), air is used.

[0004]

(2) As shown in the formula, in the negative pole, water generates at the time of fuel cell operation. Back diffusion

of a part of this water is carried out to the anode side from the cathode side, and it is discharged also from the anode side. At this time, if there is a field where water exists superfluously in the channel which supplies fuel gas, it will be generated by the water of the liquid phase and flooding (**** ball) will happen. As a result, gas supply will be barred, the performance of a cell will fall and electric generating capacity will fall. Since a reaction generates as shown in (2) types and the amount of moisture increases as fuel gas flows through the inside of a fuel cell toward the lower stream from the upper stream, this water tends to produce flooding near a fuel cell exit.

[0005]

Then, the art of preventing flooding by controlling the temperature distribution in a fuel cell is indicated by JP,H9-511356,A. It is going to prevent flooding by this conventional technology making the flow of gas, and the flow of coolant KOFURO, raising temperature toward an exit from the entrance of gas, controlling the temperature distribution in a fuel cell, using as steam the water by which it was generated and taking it into gas.

[0006]

[Problem to be solved by the invention]

However, in the conventional technology mentioned above, the gas temperature discharged from a fuel cell by that of ***** in the temperature of gas becomes high temperature. For this reason, the amount of water discharged outside increases from a fuel cell, it is easy to produce dry out (dry state), and the water balance in a fuel cell is not materialized. Therefore, the water recovery subsystem of the fuel cell lower stream was needed, and there was a problem that a system was complicated.

[0007]

This invention is made paying attention to such a conventional problem, and an object of this invention is to provide the polymer electrolyte fuel cell which can prevent generating of flooding (**** ball) and dry out (dry state), and can be generated good.

[0008]

[Means for solving problem]

This invention solves said SUBJECT by the following solving means. In order to understand easily, the numerals corresponding to the embodiment of this invention are attached, but it is not limited to this.

[0009]

The film and electrode zygote (21) to which this invention arranges an electrode layer to both sides of the electrolyte

layer of a solid polymer film, Laminate the single cell (20) which has a separator (23, 24) arranged at both the external surfaces of its film and electrode zygote (21), and it is formed, It is a polymer electrolyte fuel cell which generates electricity by carrying out conduction of the reactant gas to the separator (23, 24), Among the separators of said single cell (20), at least, [one of separators (24)] The 1st gas stream way (33) in which conduction is possible is formed in the field by the side of said film and electrode zygote for reactant gas, It is a separator of the porous type which forms in the field by the side of said film and electrode zygote, and the field by the side of opposite the 2nd gas stream way (35) in which conduction is possible for the reactant gas which carried out conduction of said 1st gas stream way, It has a communicating means (34) which opens said 1st gas stream way (33) and the 2nd gas stream way (35) for free passage.

[0010]

[Function and Effect]

According to this invention, a porous type separator by using it The lower stream side channel of a separator (2nd gas stream way), That is, water liquefied in respect of the field side by the side of a film and an electrode zygote and the opposite side can be supplied to the gas which flows through the reaction side by the side of the upper stream side channel of a separator (1st gas stream way), i.e., a film and an electrode zygote, and the dry out in hula DINGU in the lower stream and the upper stream can be prevented.

[0011]

Since a porous type separator is used and the amount of steam which can contain gas is made increased according to accumulation of produced water, it can prevent water liquefying within the upper stream side channel. When a gas inlet part and a gas outlet section approach, liquefaction of water progresses in the lower stream and the supply capability of the water to a gas inlet part improves.

[0012]

Since the amount of steam which can contain gas will be made increased according to accumulation of produced water if a solid type separator is used, it can prevent water liquefying within the upper stream side channel. When a gas inlet part and a gas outlet section approach, liquefaction of water progresses in the lower stream and the supply capability of the water to a gas inlet part improves.

[0013]

[Mode for carrying out the invention]

Hereafter, with reference to Drawings etc., an embodiment of the invention is described in more detail.

(A 1st embodiment)

Drawing 1 is a figure showing the composition of the polymer electrolyte fuel cell system concerning this invention, and the figure in which drawing 1 (A) shows the composition of a control unit, and drawing 1 (B) are the figures showing system-wide composition.

[0014]

By using a porous type bipolar plate and passing gas to back-and-front both sides of a bipolar plate, this embodiment equalizes the amount of moisture inside a cell, and prevents generating of flooding and dry out.

[0015]

As shown in drawing 1 (B), the polymer electrolyte fuel cell system of this invention has the fuel cell main part 11, the temperature sensor 12 which detects the temperature of the gas supplied to the fuel cell main part 11, and the moisture sensor 13 which detects the humidity of gas. The fuel cell system of this invention has a LLC circulation system which makes the inside of the fuel cell main part 11 circulate through long life coolant (LLC), in order to maintain the fuel cell main part 11 at the optimal temperature. As this long life coolant, there are a mixed-solution of an ethylene GURAI call and water, etc., for example. A LLC circulation system has the LLC tank 14, the pump 15, the valve 16, the temperature sensor 17, the radiator 18, and the bypass valve 19.

[0016]

As for this fuel cell system, operational status is controlled by the control unit 10. The target LLC inlet temperature calculating means 1 which computes the LLC inlet temperature used as a control target from a fuel cell load signal, a gas temperature signal, a gas humidity signal, and an outdoor-air-temperature signal as the control unit 10 is shown in drawing 1 (A), It has the gas stream road temperature degree slope calculating means 2 which computes the temperature gradient of a gas stream way, and has the amount control means 4 of heat dissipation of the radiator which controls further the flow control means 3 and the amount of heat dissipation of the radiator 18 which control the flow of LLC based on the calculation result.

[0017]

Although the porous type bipolar plate is used only for the cathode side in this embodiment, it may use for both by the side of an anode or an anode, and a cathode.

[0018]

Drawing 2 is a sectional side elevation showing the cell

configuration of a 1st embodiment of the polymer electrolyte fuel cell system concerning this invention.

[0019]

The single cell 20 A film and the electrode zygote (Membrane Electrode Assembly (it abbreviates to the following "MEA")) 21, The gas diffusion layer (GasDiffusion Layer (it abbreviates to the following "GDL")) 22 formed in the both sides, The anode bipolar plate (Bipolar Plate (a bipolar plate is hereafter abbreviated to "BPP")) 23 formed in one GDL22, It has the cathode bipolar plate (cathode BPP) 24 formed in GDL22 of another side, and the LLC plate 25 formed in the cathode BPP24.

[0020]

Although only cathode BPP24 is used as a porous type bipolar plate and anode BPP23 is considering it as the solid type plate in this embodiment, Only anode BPP23 is considered as a porous type, or it is good also as a porous type in both anode BPP23 and cathode BPP24.

[0021]

Drawing 3 is a figure showing the channel shape of the cathode BPP which is a porous type plate.

As for a surface view and drawing 3 (B), the B-B sectional view of drawing 3 (A) (or drawing 3 (C)) and drawing 3 (C) of drawing 3 (A) are back views.

[0022]

The field where as for cathode gas it is the MEA side and the reaction by reactant gas is performed via the gas inlet manifold 32 from the gas inlet part 31 (henceforth "a reaction side") This field is suitably expressed as the surface. It branches and flows into the formed reaction side gas stream way 33, and it passes through the free passage way 34, goes to the plate back (field by the side of a LLC plate opposite to a reaction side), and flows through the back gas stream way 35. And it joins by the gas outlet manifold 36, and is discharged from the gas outlet section 37.

[0023]

Drawing 4 is a sectional side elevation of the single cell used for the polymer electrolyte fuel cell system concerning this invention.

The arrow in a figure shows water movement in a cell.

[0024]

Next, movement of the water in the cathode plate which is a porous type plate is explained.

[0025]

According to this embodiment, cathode BPP24 is a porous type plate and space exists in a plate. Therefore, water can move through the inside of the plate. If water is filling the inside of a porous plate, gas will not leak from the surface (field by the side of MEA) of a porous plate to the back (field by the side of LLC) with the surface tension of the water.

[0026]

Since the LLC plate 25 exists in the back side of cathode BPP24, the back of cathode BPP24 is cooled by LLC.

Therefore, the gas which flows through the back of cathode BPP24 is low temperature from the surface side. For this reason, the gas which passes through the free passage way 34 and flows through the back gas stream way 35 is cooled, and water vapor exceeding saturated vapor pressure of a part is condensed and liquefied. And this flocculated water can pass cathode BPP24 which is a porous type plate, and moves to the front side of cathode BPP24.

[0027]

Since membranous moisture will evaporate in order to humidify the gas if gas dry when the open air was dry flows into a stack, Although it is easy to generate dry out (dry state) near the inlet section in a cell, according to this embodiment. Since the gas cooled by the LLC side of a porous type plate is condensed and the flocculated water can move freely in the inside of a porous plate, it moves to the portion (dry portion) for which the flocculated water is needed. Therefore, the humidity distribution in a cell can be kept uniform.

[0028]

As mentioned above, since the porous type separator was used for the by porous plate (this embodiment cathode BPP24) according to this embodiment, For example, when reactant gas becomes superfluous [water] in respect of the MEA side by which conduction is carried out (reaction side). When excessive water can be discharged at the back, and the reaction side by the side of MEA will be in a dry state conversely and humidity runs short, water liquefied with the back is made to permeate and dryness of reactant gas can be prevented. Thus, while being able to make the amount of moisture inside a cell able to equalize and being able to prevent the dry out of the reaction side by the side of MEA, flooding on the back can be prevented.

[0029]

Since the back of cathode BPP24 is cooled with the LLC plate 25, condensation of the water in the back gas stream way 35 can be promoted, and the supply capability of the

water from the back side to the surface side can be raised.

[0030]

Since the reaction side gas stream way 33 and the back gas stream way 35 were made to adjoin in respect of the back and front of cathode BPP24, Since it can be uniform in respect of [whole] a reaction, and water can be supplied now to a reaction side from the back and also the gas outlet section 37 and the gas inlet part 31 were made to approach, water can be effectively supplied to the gas of an entrance from the gas of an exit with much flocculated water.

[0031]

Since the penetration hole formed in cathode BPP24 was made into the free passage way, the composition of a fuel cell can be simplified and it can miniaturize.

[0032]

(A 2nd embodiment)

Drawing 5 is a sectional side elevation showing the single cell of a 2nd embodiment of the polymer electrolyte fuel cell system concerning this invention.

It is a figure equivalent to drawing 4 of a 1st embodiment.

[0033]

In each embodiment shown below, the same numerals are given to the portion which achieves the same function as a 1st embodiment mentioned above, and the overlapping explanation is omitted suitably. Since it is the same as drawing 1 of a 1st embodiment, the system structure figure of this embodiment is omitted.

[0034]

The free passage way 34 of cathode BPP24 is [single cell 20 of this embodiment] different to the single cell of a 1st embodiment. It is the feature to make the gas pressure of the reaction side gas stream way 33 of cathode BPP24 and the gas pressure of the back gas stream way 35 produce differential pressure by this.

[0035]

That is, the free passage way 34 of cathode BPP24 of this embodiment has a cross-section area of a hole smaller than the cross-section area of the reaction side gas stream way 33. For this reason, when cathode gas passes through the free passage way 34, pressure loss occurs, and the gas pressure (P_b) of the back gas stream way 35 becomes lower than the gas pressure (P_a) of the reaction side gas stream way 33. Conversely, if it says, the gas pressure (P_a) of the reaction side gas stream way 33 is higher than the gas pressure (P_b) of the back gas stream way 35. At this time, the differential pressure of 10kPa is secured by P_a and P_b ,

for example. Thus, since the gas pressure P_a of the reaction side gas stream way 33 is higher than the gas pressure P_b of the back gas stream way 35, the water generated on the reaction side gas stream way 33 moves to the inside of cathode BPP24.

[0036]

Since the surface of cathode BPP24 is a reaction side of MEA, when flooding occurs on the reaction side gas stream way 33, there should be a possibility that diffusion of cathode gas may be checked and the performance of a cell may fall. However, since the water generated on the reaction side gas stream way 33 moves in the inside of cathode BPP24 as above-mentioned according to this embodiment, generating of FURADDENGU by the side of a reaction side can be prevented certainly, and the degradation of a cell can be prevented. If the water taken into the inside of cathode BPP24 which is a porous plate runs short of moisture, it will move to an inlet section and will humidify entrance gas.

[0037]

Thus, since the hole of the free passage way 34 was made for the cross-section area to become smaller than the cross-section area of the reaction side gas stream way 33 according to this embodiment, the gas pressure of the reaction side gas stream way 33 turns into high pressure rather than the gas pressure of the back gas stream way 35. Since that flocculated water can be discharged to the back gas stream way 35 side according to this pressure difference through cathode BPP24 which is a porous separator when superfluous water condenses on the reaction side gas stream way 33, While being able to prevent FURADDENGU by the side of the reaction side gas stream way 33, the moisture cloth of the cells can be equalized.

[0038]

It is not necessary to establish a pressure setting means as an external device.

[0039]

(A 3rd embodiment)

Drawing 6 is a figure showing the channel shape of a 3rd embodiment of the polymer electrolyte fuel cell system concerning this invention.

It is a figure equivalent to drawing 3 of a 1st embodiment. As for a surface view and drawing 6 (B), the B-B sectional view of drawing 6 (A) (or drawing 6 (C)) and drawing 6 (C) of drawing 6 (A) are back views.

[0040]

According to this embodiment, the shape of the gas stream

way of cathode BPP24 is different to a 1st embodiment. Since it is the same as drawing 1 of a 1st embodiment, a system structure figure is omitted.

[0041]

In a 3rd embodiment, it is the feature that gas moved between ***** channels on the reaction side gas stream way formed in the surface of the cathode BPP to a 1st embodiment (drawing 3). Namely, in this embodiment, as for cathode BPP24, two kinds of reaction side gas stream ways 33a and 33b are formed in the surface by turns (drawing 6 (A)). The 1st reaction side gas stream way 33a branches from the gas inlet manifold 32, and the opposite end serves as a dead end. The 2nd reaction side gas stream way 33b is formed between the 1st reaction side gas stream ways 33a, and is not connected to the gas inlet manifold 32. The gas inlet manifold 32 and opposite side is opening the 2nd reaction side gas stream way 33b for free passage on the back gas stream way 35 via the free passage way 34.

[0042]

The gas which flowed into the 1st reaction side gas stream way 33a from the gas inlet manifold 32 passes along GDL22 of porous structure, and moves to the next 2nd reaction side gas stream way 33b.

[0043]

Drawing 7 is a flat section showing gas movement between the gas stream ways of a 3rd embodiment.

[0044]

The gas which moves to the 2nd reaction side gas stream way 33b from the 1st reaction side gas stream way 33a passes GDL22, as shown in drawing 7. Therefore, diffusion of gas is promoted in GDL22. Therefore, MEA21 will be crossed to the whole surface and will be utilized for a reaction. In addition, since there is an operation which drains the surplus moisture when cathode gas passes GDL22 when surplus moisture occurs in GDL22, gas diffusion cannot be easily checked by water.

[0045]

Thus, since according to this embodiment cathode gas passes GDL22 and flows, a gas diffusion loss decreases, a reaction arises all over MEA21, diffusion of gas is promoted, the performance of a stack improves, and fuel cell performance improves.

[0046]

(A 4th embodiment)

Drawing 8 is a sectional side elevation showing the cell configuration of a 4th embodiment of the polymer

electrolyte fuel cell system concerning this invention.
It is a figure equivalent to drawing 2 of a 1st embodiment.

[0047]

Since it is the same as drawing 1 of a 1st embodiment, the system structure figure of this embodiment is omitted.

[0048]

The shape of the free passage way of cathode BPP24 is [this embodiment] different to a 1st embodiment. The free passage way of this embodiment is formed as an external manifold.

[0049]

Although the reaction side gas stream way 33 and the back gas stream way 35 are made to open for free passage at a 1st embodiment by forming the free passage way 34 of a penetration hole in cathode BPP24 as a free passage way, The free passage manifold 81 is formed in the exterior of the single cell 20, and the reaction side gas stream way 33 and the back gas stream way 35 are made to open for free passage in this embodiment. The differential pressure adjustment mechanism 82 which can adjust differential pressure by adjusting the effective height of the free passage manifold 81 is formed in the inside of the free passage manifold 81.

[0050]

Drawing 9 is a diagram showing the gas pressure difference of the reaction side gas stream way and back gas stream way to a gas mass flow at the time of using a penetration hole as a free passage way (for example, a 2nd embodiment). A gas mass flow is taken along a horizontal axis, and a gas pressure difference is taken along a vertical axis.

[0051]

If the load of a fuel cell increases, a gas mass flow will increase, but if a gas mass flow increases, pressure difference will become large, and this drawing 9 shows that pressure difference is also small, when there are few gas mass flows. Thus, since pressure difference is small when there are few gas mass flows, the drainage effect of the water by the side of the reaction side gas stream way 33 is small.

[0052]

Drawing 10 is a diagram showing effective height [of the manifold to the gas mass flow in a 4th embodiment] h , and differential pressure $P_a - P_b$ at that time. Effective height h is taken along a gas mass flow and a left-hand side vertical axis, and differential pressure $P_a - P_b$ is taken along a right-hand side vertical axis at a horizontal axis.

[0053]

The effective height of the free passage manifold 81 can be adjusted by the differential pressure adjustment mechanism 82, and differential pressure can be controlled by this embodiment.

[0054]

If effective height h of a manifold is made small from this drawing 10 when a gas mass flow is made small (namely, when the load of a fuel cell becomes small), it turns out that differential pressure $P_a - P_b$ can be kept constant. That is, when changing a gas mass flow, differential pressure $P_a - P_b$ can be kept constant by adjusting effective height h of a manifold suitably according to it.

[0055]

Thus, since differential pressure $P_a - P_b$ of the gas between channels can be kept constant according to this embodiment, without being based on a flow, generating of flooding can always be prevented.

[0056]

The structure of a separator (cathode BPP) can be simplified. The produced water produced in respect of the reaction can once be equalized, and it can introduce into the back.

[0057]

The pressure loss of the reaction side gas stream way 33 and the back gas stream way 35 can be controlled, and pressure difference can be adjusted.

[0058]

It cannot depend on load (flow), but pressure difference can be kept constant again, and the eccentric nature to the back of the produced water produced in the reaction side side can be maintained.

[0059]

(A 5th embodiment)

Drawing 11 is a figure showing the LLC plate of a 5th embodiment of the polymer electrolyte fuel cell system concerning this invention.

[0060]

The system structure of this embodiment, a cell configuration, and cathode plate shape are the same as a 1st embodiment, and since it is the same as that of drawing 1, drawing 2, and drawing 3 respectively, they are omitted.

[0061]

This 5th embodiment is controlled so that the balance of the amount of moisture generated inside having established the temperature gradient to the direction of a flow of a gas

stream way to a 1st embodiment and the fuel cell main part 11 and the amount of moisture carried out to the exterior of the fuel cell main part 11 is materialized.

[0062]

The LLC channel 113 formed in the LLC plate 25 serves as the Serpentine type. LLC which flowed from the LLC entrance 111 branches to the LLC channel 113, after passing the LLC entrance manifold 112. Then, after passing the channel of a cuff, it joins by the LLC outlet manifold 114, and is discharged from the LLC exit 115. Temperature **** it as it flows into the LLC exit 115 from the LLC entrance 111, since LLC absorbs the heat generated by the fuel cell main part 11. Considering a relation with the gas stream way shown in drawing 3, temperature rises toward the free passage way 34 from the gas inlet part 31. On the contrary, at the time of a return, it becomes the arrangement to which temperature falls toward the gas outlet section 37 from the free passage way 34.

[0063]

Drawing 12 is a diagram showing the saturated vapor pressure which temperature receives. Temperature is taken along a horizontal axis and saturated vapor pressure is taken along a vertical axis.

[0064]

It turns out that temperature takes for becoming high and saturated vapor pressure becomes large rapidly from this drawing 12. If the temperature of gas goes up this, only the part shows that gas can hold moisture in the state of the gaseous phase. Conversely, if temperature falls, gas cannot hold moisture in the state of the gaseous phase, but water will condense and liquefy.

[0065]

Drawing 13 is a diagram showing the relation between the relative humidity to the position in the gas stream way of this embodiment, the amount of moisture, and temperature. Relative humidity is taken along the position in a gas stream way, and a left-hand side vertical axis, and the amount of moisture and temperature are taken along a right-hand side vertical axis at a horizontal axis.

[0066]

As mentioned above, on the surface of cathode BPP24, the temperature of gas rises until it arrives at the free passage way 34 (return section) through the reaction side gas stream way 33 from the gas inlet part 31. For this reason, when generated by produced water, the relative humidity of gas will be 100%, it is not saturated, it serves as super saturation, and water condensation is not carried out. As a

result, hula DINGU does not occur on the reaction side gas stream way 33.

[0067]

In the back of cathode BPP24, the temperature of gas falls as it goes to the gas outlet section 37 from the free passage way 34 (return section). For this reason, the amount of moisture will become more than moisture that may be included at the time of saturation, relative humidity will always be not less than 100%, and the water for super saturation is condensed in respect of a plate, and is liquefied. However, since the cathode BPP is a porous type, it moves in the inside of a plate, moisture moves to the required surface side, and liquefied water is used for humidification of gas.

[0068]

Thus, according to this embodiment, generating of flooding in the reaction side gas stream way 33 can be prevented by giving a temperature gradient in the direction of a flow of a gas stream way. Prevention of the channel blockade by flooding of the back gas stream way 35 and the prompt humidification to the gas which flows from the entrance 31 of the cathode BPP can be reconciled.

[0069]

Drawing 14 is a diagram showing the relation of the water balance formation temperature to the rate of gas utilization at the time of fixing operating pressure power of a fuel cell. The rate of gas utilization is taken along a horizontal axis, and water balance formation temperature is taken along a vertical axis.

[0070]

In a fuel cell, as mentioned above, water is generated by the reaction, and the gas which holds this water as steam is discharged. Therefore, when there is no humidifier upstream of a fuel cell, dry gas flows into a fuel cell for example, and the temperature of the gas discharged from a fuel cell is high, the water more than the water generated will be away held by emission gas.

[0071]

In such the state, if the water more than the water generated is away held by emission gas, the water in a fuel cell will decrease in number, and dry out will be produced.

[0072]

Since such a situation is not produced, it is important to form the balance (water balance) of the amount of moisture generated inside a fuel cell main part and the amount of moisture carried out to the exterior of a fuel cell main part. If a water recovery subsystem is installed downstream from

a fuel cell, water is collected and the water in a fuel cell runs short when water balance cannot be formed within a fuel cell, it is necessary to humidify the gas which flows into a fuel cell using this collected water. Thus, a system becomes complicated when water balance cannot be formed within a fuel cell.

[0073]

When the operating pressure power of a fuel cell was set constant, it was decided by relation between the gas temperature of a fuel cell exit, and the rate of gas utilization whether this water balance will be materialized, and it showed drawing 14 this relation. Water balance formation temperature means the gas temperature of the fuel cell exit discharged from a fuel cell, when water balance is materialized.

[0074]

As shown in this drawing 14, water balance formation temperature serves as a function of the rate of gas utilization. Since the quantity of exhaust gas becomes less when the rate of gas utilization is large, gas has, last amount of moisture becomes less, and water balance formation temperature becomes high. On the contrary, since the quantity of exhaust gas increases when the rate of gas utilization is small, gas has, last amount of moisture increases, and water balance formation temperature becomes low.

[0075]

Drawing 15 is a diagram showing the relation of the water balance formation temperature to operating pressure power and the rate of gas utilization. Operating pressure power is taken along a horizontal axis, and the rate of gas utilization is taken along a vertical axis.

[0076]

Based on the relation mentioned above, the relation of the water balance formation temperature to operating pressure power and the rate of gas utilization is further shown in drawing 15.

[0077]

Since gas has and last amount of moisture decreases so that operating pressure power (namely, gas pressure at the time of operation) becomes high, water balance formation temperature becomes high. Therefore, water balance formation temperature becomes high, so that the rate of gas utilization is so large that operating pressure power is high. Thus, in drawing 15, a upper right diagram is [water balance formation temperature] high temperature, and a

lower left diagram is [water balance formation temperature] low temperature. If this drawing 15 is used, when changing the operating pressure power of a fuel cell, it can ask for the water balance formation temperature for forming water balance, and the rate of gas utilization at that time.

[0078]

In order considering controlling the temperature of a fuel cell using LLC to form water balance within a fuel cell under a certain operating pressure power and rate of gas utilization, it is necessary to cool the gas temperature (henceforth "gas outlet temperature") of the exit 37 of a fuel cell even to a certain temperature by LLC. For example, the LLC plate 25 shown in drawing 11 is used, and the temperature of the gas discharged from a fuel cell is controlled by LLC which flows through the LLC channel 113. However, due to heat exchange efficiency, since gas outlet temperature cannot be cooled below to the inlet temperature of LLC, it is necessary to set the inlet temperature of LLC as a temperature lower than water balance formation temperature.

[0079]

Since the value of the LLC inlet temperature for making gas outlet temperature into water balance formation temperature is decided by the characteristic peculiar to fuel cells, such as thermal conductivity and channel shape, beforehand, it prepares the relation of the LLC inlet temperature to gas outlet temperature, and can ask for it by referring to this.

[0080]

Thus, if operating pressure power and the rate of gas utilization are decided, the gas outlet temperature for forming water balance will be decided, and the LLC inlet temperature for using the gas outlet temperature will be determined.

[0081]

In order to prevent flooding in the middle of a channel, it is necessary to also control the temperature in the middle of a channel, and temperature near the return section (free passage way 34) of a gas stream way is made into target temperature. For this reason, the temperature which should be filled at the LLC exit 115 arranged near the return section (free passage way 34) of a gas stream way becomes settled, and the temperature gradient of the LLC temperature for using such a temperature is needed.

[0082]

Thus, in order to form water balance, preventing flooding. In consideration of the calorific value of a fuel cell, and the

amount of heat dissipation in a radiator, it is necessary to control the temperature of the entrance 111 of LLC, and the exit 115 to a desired value, and to control the flow of LLC to become a predetermined temperature and temperature gradient of the LLC entrance 111 for this reason.

[0083]

Drawing 16 is a diagram showing the relation of the temperature gradient of LLC to gas inlet temperature and gas inlet humidity. Gas inlet temperature is taken along a horizontal axis, and gas inlet humidity is taken along a vertical axis.

[0084]

The temperature gradient of LLC is enlarged, so that gas inlet humidity is so high that gas inlet temperature is high. When open air conditions change by controlling in this way, generating of hula DINGU can be prevented certainly.

[0085]

Drawing 17 is a diagram showing the temperature gradient correction coefficient to the rate of gas utilization. The rate of gas utilization is taken along a horizontal axis, and a temperature gradient correction coefficient is taken along a vertical axis.

[0086]

Although drawing 16 explained by the case where the capacity factor of gas is constant, in changing the capacity factor of gas, necessity has amendment, and the temperature gradient correction coefficient to the rate of gas utilization was shown in drawing 17.

[0087]

Since gas can hold many amounts of moisture by the gaseous phase so that the rate of gas utilization is small, a temperature gradient can be made small. On the contrary, since gas of the amount of moisture which can be held by the gaseous phase will decrease if the rate of gas utilization is large, a big temperature gradient is needed. In consideration of such the characteristic, a temperature gradient is amended with a temperature gradient correction coefficient.

[0088]

Drawing 18 is a diagram showing the temperature gradient in the fuel cell cell to the total amount of LLC circulation which flows through a LLC channel. The amount of LLC circulation is taken along a horizontal axis, and a temperature gradient is taken along a vertical axis.

[0089]

The amount of LLC circulation which is needed in order to

attain the temperature gradient which should be made a target from this figure can be determined. A temperature gradient can be enlarged, so that the amount of LLC circulation is lessened. That is, a temperature change until LLC arrives at the exit 115 from the entrance 111 so that there are few amounts of LLC circulation is large, and a temperature change until LLC arrives at the exit 115 from the entrance 111 is so small that there are many amounts of LLC circulation.

[0090]

Drawing 19 is a diagram showing the relation between LLC temperature and the amount of radiator heat dissipation. LLC temperature is taken along a horizontal axis and the amount of radiator heat dissipation is taken along a vertical axis.

[0091]

By this drawing 19, the amount of radiator heat dissipation required in order to make temperature of LLC into the above-mentioned LLC inlet temperature is calculated.

[0092]

Drawing 20 is a diagram showing the relation between the amount of LLC(s) which passes a radiator when outdoor air temperature is set constant, and the amount of heat dissipation in which a radiator radiates heat. The amount of LLC(s) is taken along a horizontal axis, and the amount of heat dissipation is taken along a vertical axis.

[0093]

It puts on the system shown in drawing 1, and the amount of LLC(s) which bypasses the radiator 18 and flows increases, and the amount of heat dissipation of the radiator 18 becomes small, so that the amount of LLC(s) which passes the radiator 18 becomes small. On the contrary, the amount of LLC(s) which bypasses the radiator 18 and flows decreases, and the amount of heat dissipation of the radiator 18 becomes large, so that the amount of LLC(s) which passes the radiator 18 increases. Therefore, by controlling the amount of LLC(s) which passes the radiator 18, the amount of heat dissipation from the radiator 18 can be controlled, and the calorific value from the fuel cell main part 11 which changes with operating conditions can be processed appropriately. Since the amount of heat dissipation of a radiator changes with outdoor air temperature, drawing 21 needs to amend the amount of radiator passage LLC(s) according to outdoor air temperature.

[0094]

Drawing 21 is a diagram showing the relation of the amount correction coefficient of radiator passage LLC(s) to outdoor air temperature. Outdoor air temperature is taken along a horizontal axis, and a correction coefficient is taken along a vertical axis.

[0095]

Since the amount of heat dissipation of the radiator 18 is changed with outdoor air temperature as above-mentioned, the correction coefficient calculated by this drawing 21 needs to amend the amount of radiator passage LLC(s).

[0096]

Drawing 22 is a flow chart which shows control of a 5th embodiment.

[0097]

In introduction and Step (it is written as the following "S") 1, outdoor air temperature is measured with a thermometer.

[0098]

In S2, gas inlet humidity is measured with a hygrometer.

[0099]

In S3, operating pressure power (= gas pressure) is measured with the opening of a pressure gauge or a pressure valve.

[0100]

In S4, gas supply volume is measured with a flow instrument or a blower output.

[0101]

In S5, a current value is measured with an ammeter.

[0102]

In S6, the amount of gas utilization is computed from the current value measured by S5.

[0103]

The rate of gas utilization is computed in S7. Specifically, it is computable with the amount of rate of gas utilization = gas utilization (calculation value of S6) / gas supply volume (the amount of measurement of S4).

[0104]

In S8, water balance formation temperature is computed to drawing 15 with the application of operating pressure power (measured value of S3), and the rate of gas utilization (calculation value of S7).

[0105]

In S9, LLC inlet temperature is computed from water balance formation temperature (calculation value of S8) based on the fuel cell characteristic.

[0106]

In S10, a LLC temperature gradient is computed to drawing

16 with the application of gas inlet temperature (= water balance formation temperature (calculation value of S8)), and gas inlet humidity (measured value of S2).

[0107]

In S11, with the application of the rate of gas utilization (calculation value of S7), a LLC temperature gradient correction coefficient is computed to drawing 17, and a LLC temperature gradient (calculation value of S10) is amended.

[0108]

In S12, the amount of LLC circulation is computed with the application of the amended LLC temperature gradient to drawing 18.

[0109]

In S13, the amount of radiator heat dissipation is computed to drawing 19 with the application of LLC inlet temperature (calculation value of S9).

[0110]

In S14, the amount of radiator passage LLC(s) is computed to drawing 20 with the application of the amount of radiator heat dissipation (calculation value of S13).

[0111]

In S15, with the application of outdoor air temperature (measured value of S1), the amount correction coefficient of radiator passage LLC(s) is computed to drawing 21, and the amount of radiator passage LLC(s) (calculation value of S14) is amended.

[0112]

In S16, the output of the pump 15 (refer to drawing 1) and the opening of the bypass valve 19 (refer to drawing 1) are controlled based on the amount of radiator passage LLC(s) (amendment value of S15).

[0113]

According to this embodiment, the amount of heat dissipation from the radiator 18 is appropriately controllable by controlling the amount of LLC circulation, and the amount of LLC(s) which passes a radiator. The temperature of the entrance 111 of LLC and the exit 115 can be controlled by this, and it becomes possible to control the gas temperature which flows through cathode BPP24, and the water balance in a fuel cell can be formed, preventing flooding from occurring in a channel.

[0114]

It can prevent water liquefying the amount of steam which can contain gas in the reaction side gas stream way 33, since it is made to increase according to accumulation of produced water. When the gas inlet part 31 and the gas

outlet section 37 approach, liquefaction of water progresses in the lower stream (back gas stream way 35), and the supply capability of the water to the gas inlet part 31 improves.

[0115]

To compensate for the state of gas, or generation of water, it can prevent finely water liquefying superfluously in the reaction side gas stream way 33.

[0116]

(A 6th embodiment)

Drawing 23 is a sectional side elevation showing the cell configuration of a 6th embodiment of the polymer electrolyte fuel cell system concerning this invention.

[0117]

Since it is the same as drawing 1 of a 1st embodiment, the system structure figure of this embodiment is omitted.

[0118]

A 6th embodiment was taken as the channel that water balance is materialized, using solid type BPP which does not penetrate water for the by PORAPU rate (BPP) which constitutes a fuel cell cell.

[0119]

The single cell 20 has MEA21, GDL22, anode BPP23, cathode BPP24, and the LLC plate 25. In this embodiment, both the anode BPP and the cathode BPP are solid type plates.

[0120]

Drawing 24 is a figure showing the cathode BPP of a 6th embodiment.

Drawing 24 (A) is a surface view and drawing 24 (B) is a B-B sectional view of drawing 24 (A).

[0121]

The channel shape of cathode BPP24 is shown in drawing 24. Cathode gas is supplied from the gas inlet part 31, branches and flows into the outward trip gas stream way 33c via the gas inlet manifold 32, is turned up by return on 33 d of gas stream ways, and flows into the return trip gas stream way 33e. Then, the cathode gas is made to join by the gas outlet manifold 36 formed in the back of cathode BPP24 via the free passage way 34, and is discharged from the gas outlet section 37.

[0122]

Drawing 25 is a flat section showing movement of the water between the channels of a 6th embodiment.

[0123]

Unlike the porous plate mentioned above, within a solid plate, water is unmovable. Therefore, liquid hydrogen of the surplus generated downstream from the channel returns to the channel upper stream side via GDL22. The thing of the same channel as the channel shown in drawing 11 is used for the LLC plate 25. Therefore, on the gas stream way of cathode BPP24 shown in drawing 24, the gas inlet manifold [by which the entrance side of a LLC channel is arranged] 32, and gas outlet manifold 36 side serves as low temperature. On the other hand, 33 d of cuff gas stream ways equivalent to a LLC outlet side are high temperature. Therefore, on the outward trip gas stream way 33c, temperature **** to the direction of a flow. Therefore, the water generated at the reaction is taken in into gas by the rise of water vapor pressure. On the other hand, on the return trip gas stream way 33e to which temperature falls to the direction of a flow, the water of the liquid phase arises due to the fall of saturated vapor pressure. Here, since the outward trip gas stream way 33c adjoins in parallel to the return trip gas stream way 33e as shown in drawing 24, the water of the surplus generated on the return trip gas stream way 33e passes along GDL22 which is porous structure, and moves to the outward trip gas stream way 33c which runs short of moisture.

[0124]

Also in this embodiment, LLC temperature control in which water balance is materialized within a fuel cell is performed like a 5th embodiment.

[0125]

The water balance in a fuel cell can be formed preventing flooding in the inside of a channel, when a solid plate is used for a bipolar plate by considering it as the composition of a cell which was mentioned above, and a channel according to this embodiment.

[0126]

It can prevent water liquefying the amount of steam which can contain gas in the reaction side gas stream way 33, since it is made to increase according to accumulation of produced water. When the gas inlet part 31 and the gas outlet section 37 approach, liquefaction of water progresses in the lower stream (back gas stream way 35), and the supply capability of the water to the gas inlet part 31 improves.

[0127]

To compensate for the state of gas, or generation of water, it can prevent finely water liquefying superfluously in the reaction side gas stream way 33.

[0128]

Without being limited to the embodiment described above, various modification and change are possible within the limits of the technical idea, and they of this invention and an equivalent thing are also clear to it.

[0129]

For example, although only the cathode BPP is used as a porous type bipolar plate and the anode BPP is used as the solid type plate in the 1-5th embodiments, Only the anode BPP is considered as a porous type, or it is good also as a porous type in both the anode BPP and the cathode BPP.

[Brief Description of the Drawings]

[Drawing 1] It is a figure showing the composition of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 2] It is a sectional side elevation showing the cell configuration of a 1st embodiment of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 3] It is a figure showing the channel shape of the cathode BPP which is a porous type plate.

[Drawing 4] It is a sectional side elevation of the single cell used for the polymer electrolyte fuel cell system concerning this invention.

[Drawing 5] It is a sectional side elevation showing the single cell of a 2nd embodiment of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 6] It is a figure showing the channel shape of a 3rd embodiment of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 7] It is a flat section showing gas movement between the gas stream ways of a 3rd embodiment.

[Drawing 8] It is a sectional side elevation showing the cell configuration of a 4th embodiment of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 9] It is a diagram showing the gas pressure difference of the reaction side gas stream way and back gas stream way to a gas mass flow at the time of using a penetration hole as a free passage way (for example, a 2nd embodiment).

[Drawing 10] It is a diagram showing effective height [of the manifold to the gas mass flow in a 4th embodiment] h , and differential pressure $P_a - P_b$ at that time.

[Drawing 11] It is a figure showing the LLC plate of a 5th embodiment of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 12] It is a diagram showing the saturated vapor

pressure which temperature receives.

[Drawing 13] It is a diagram showing the relation between the relative humidity to the position in the gas stream way of this embodiment, the amount of moisture, and temperature.

[Drawing 14] It is a diagram showing the relation of the water balance formation temperature to the rate of gas utilization at the time of fixing operating pressure power of a fuel cell.

[Drawing 15] It is a diagram showing the relation of the water balance formation temperature to operating pressure power and the rate of gas utilization.

[Drawing 16] It is a diagram showing the relation of the temperature gradient of LLC to gas inlet temperature and gas inlet humidity.

[Drawing 17] It is a diagram showing the temperature gradient correction coefficient to the rate of gas utilization.

[Drawing 18] It is a diagram showing the temperature gradient in the fuel cell cell to the total amount of LLC circulation which flows through a LLC channel.

[Drawing 19] It is a diagram showing the relation between LLC temperature and the amount of radiator heat dissipation.

[Drawing 20] It is a diagram showing the relation between the amount of LLC(s) which passes a radiator when outdoor air temperature is set constant, and the amount of heat dissipation in which a radiator radiates heat.

[Drawing 21] It is a diagram showing the relation of the amount correction coefficient of radiator passage LLC(s) to outdoor air temperature.

[Drawing 22] It is a flow chart which shows control of a 5th embodiment.

[Drawing 23] It is a sectional side elevation showing the cell configuration of a 6th embodiment of the polymer electrolyte fuel cell system concerning this invention.

[Drawing 24] It is a figure showing the cathode BPP of a 6th embodiment.

[Drawing 25] It is a flat section showing movement of the water between the channels of a 6th embodiment.

[Explanations of letters or numerals]

1 Target LLC inlet temperature calculating means

2 Gas stream road temperature degree slope calculating means

3 Flow control means

4 Amount control means of heat dissipation

10 Control unit

11 Fuel cell main part
14 LLC tank
18 Radiator
19 Bypass valve
20 Single cell
21 Film and electrode zygote (MEA)
22 Gas diffusion layer (GDL)
23 Anode bipolar plate; anode BPP (separator)
24 Cathode bipolar plate; cathode BPP (separator)
25 LLC plate (separator cooling method)
31 Gas inlet part
33 Reaction side gas stream way (1st gas stream way)
33a The 1st reaction side gas stream way (entrance passage part)
33b The 2nd reaction side gas stream way (exit passage part)
33c Outward trip gas stream way
33 d Cuff gas stream way (turned part)
33e Return trip gas stream way
34 Free passage way (communicating means)
35 Back gas stream way (2nd gas stream way)
37 Gas outlet section
81 Free passage manifold (communicating means)
82 Differential pressure adjustment mechanism (pressure loss control means)

[Translation done.]

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[Japanese \(whole document in PDF\)](#)